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14. ABSTRACT:

The goal of Distributed Diagnosis and Home Healthcare (D2H2) is to improve quality of care and patient wellness and outcomes by transforming the delivery of healthcare from a central, hospital-based system to one that is more distributed, patient-centered and home-based. D2H2 will benefit patients by improving the quality and convenience of care, controlling healthcare cost, and preventing medical errors, thus leading to increased access to affordable and effective healthcare.

In the 1st Transdisciplinary Conference on Distributed Diagnosis and Home Healthcare (D2H2), leaders from industry, academia and government participated in active discussion with more than 200 participants to exchange ideas and to discuss various aspects of issues and opportunities associated with realization of the D2H2, including the current status, important components/ingredients, their enabling technologies, and policies. This report summarizes activities at the conference.

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MARRIOTT CRYSTAL GATEWAY

ARLINGTON, VIRGINIA

APRIL 2-4, 2006

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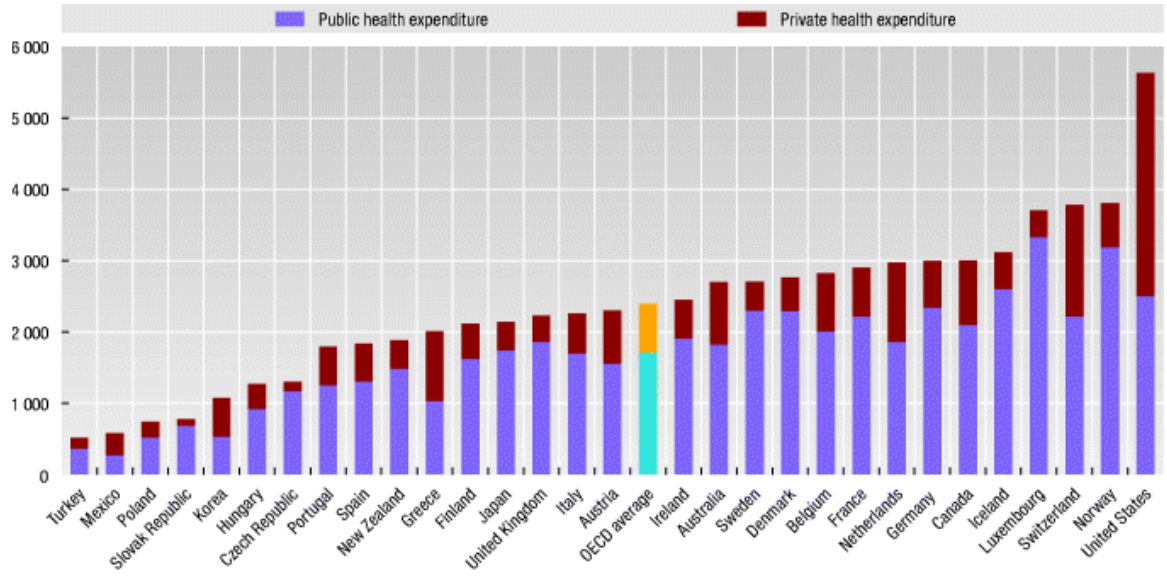
CONFERENCE REPORT

1ST TRANSDISCIPLINARY CONFERENCE ON DISTRIBUTED DIAGNOSIS AND HOME HEALTHCARE (D_2H_2)

INTRODUCTION

The current U.S. healthcare system faces serious challenges on multiple fronts. Although the U.S. is considered the best place for patients to obtain accurate diagnoses and high-quality treatment, more than 46 million Americans currently do not have health insurance in 2006 due to the high healthcare costs and government inability to cover them. In the past ten years, national healthcare expenditure in the U.S. has nearly doubled from $966 billion in 1994 to $1.877 trillion in 2004. Expenditure as a proportion of GDP has also risen from 13.7% in 1994 to around 16% in 2004[1]. In addition, U.S. total expenditure on health per capita is more than double that of the OECD average[2]. Increased use of prescription drugs, imaging, and other therapeutics has contributed to a substantial rise in healthcare expenses in the last several decades. These expanding costs along with the growing number of retirees and people with chronic conditions and the growing uninsured population are clearly leading to an unsustainable situation for the current healthcare system in the U.S.

Public and private expenditure on health
US dollars per capita, calculated using PPPs (purchasing power parties) in 2003



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[1] http://www.cms.hhs.gov/NationalHealthExpendData/downloads/nhe65-15.zip

[2] http://hermia.sourceoecd.org/vl=3884274/cl=13/nw=1/rpsv/factbook/10-01-04-g01.htm

The current healthcare system is undoubtedly inefficient and transformation is direly needed. New technology and advances must not only improve care but also be cost-efficient. The delivery system must shift its focus from costly end-of-term care to prevention and screening technologies in order to contain costs while maintaining a high level of quality. It is imperative to get stakeholder agreement now so that we may reengineer and introduce a more efficient healthcare delivery system for the 21st century.

Distributed Diagnosis and Home Healthcare (D_2H_2) has been proposed as a new delivery framework to transform healthcare from a central, hospital-based system to one that is more patient-centered, distributed and home-based. The vision is that D_2H_2 will benefit patients and society by improving the quality and convenience of care, controlling healthcare costs, and increasing access to affordable and effective healthcare in the world. Leaders from academia, industry, and the government gathered at the first Transdisciplinary Conference on Distributed Diagnosis and Home Healthcare (D_2H_2) held in Arlington, VA on April 2-4, 2006.

The purpose of the conference was to bring together the major stakeholders from industry, academia, and government and provide a means for discussing the current status of healthcare both in the U.S. and globally, important components/ingredients, new technologies, and policies to facilitate acceptance of distributed, home healthcare delivery in the future. Leaders would also discuss how this transformation would take place as well as the technical and non-technical challenges involved. Due to the complexity and scope of D_2H_2, collaboration between researchers, engineers, and providers from many traditional disciplines will be required in order to overcome the potential obstacles and realize the full potential benefits of D_2H_2. The D_2H_2 conference had a number of sessions including sessions on point-of-care diagnostics, home devices, security and standards, and policies and strategies. Each session allowed the opportunity to hear 3-6 speakers describe his/her experiences and share insight on the topic. This report summarizes keynote speakers' talks at the conference regarding the future healthcare delivery paradigm.

OPENING AND VISION

Dr. Lee Huntsman, President Emeritus of the University of Washington, kicked off the conference with his bold vision of healthcare in the 21st century. He describes our current healthcare delivery system as akin to the plateau phase reached by sailing ships in the mid 1800s. In the early 1800s, sailing technology had improved quickly similar to the rapid improvements in healthcare during the 20th century. However, improvements in sailing peaked in the 1850s with a sustained speed of 22 knots, and people spent the next half century seeking incremental improvements. Towards the end of the 19th century, steam-powered ships arrived, and all of the sudden they very quickly replaced the new, obsolete sailing ships. Right now in the early part of the 21st century, Dr. Huntsman believes, is the time where we must actively take steps to develop the equivalent of the healthcare "steamship." A breakout strategy leading to improvements in the quality of care and patient outcomes as well as lower healthcare expenditures can be achieved through social reengineering, global health, and technology.

He mentions that much of success and advancement is due to the development of new tools, and this development period has been foreshortened due to a closer linkage between basic sciences and clinical care. This focus on translational research is vital in developing new technologies to transform the undoubtedly inefficient and costly current system of healthcare into a more effective and lower cost distributed delivery framework. However, such a transformation may be difficult due to pushback from the various current stakeholders who have interests that may be affected by this transformation. He states that the U.S. healthcare situation is not all gloomy, however. Many other countries, such as Norway and Singapore, still look to the U.S. for leadership. They still believe that the pervasive risk-taking culture in the U.S. is one of its biggest strengths. In fact, many foreign universities are sending their undergraduate and graduate students to the U.S. to understand what it is about U.S. culture that makes its education and training so unique. Although there are many barriers in the path to the "harbor" of life sciences and medicine, he believes that by unleashing the power of technology, we will be able to achieve better healthcare for everyone.

Dr. J.-C. Healy, Director of the Office of Assistant Director General of the World Health Organization (WHO), gave a sobering picture of the current healthcare delivery system. Many health problems include demographic factors, globalization, and the economic viability of various delivery systems. The aging global population is one key demographic factor leading to an increase in chronic diseases and an inversion of the worker-non worker ratio in both developed and developing countries. An enormous global problem is chronic disease; 80% of deaths occur in low and middle income countries where most of the population lives. In addition, globalization has increased the mobility of both people and diseases, SARS being a defining example of how quickly diseases from the developing countries can reach developed countries. Solutions to these issues revolve around cost containment, organizations to oversee global health, aligning users' demands and attitudes, and developing new technologies. However, bottlenecks, such as the conservative attitudes of the actors (professionals, authorities, and patients), a lack of investment in the right places and a lack of new concepts and vision, have thus far prevented the successful implementation of these solutions.

Dr. Healy sees technology as the driving force behind change. He sees the e-health industry as the next pillar, which will dramatically improve the delivery of healthcare. The pharmaceutical industry, the first pillar, was funded at the end of the 19th century and based on chemistry. The second pillar, the medical imaging industry, was funded throughout the 20th century and based on physics. The driving force behind the e-health industry, the third pillar of healthcare, will be electronics and mathematics and will require

around 5% of total healthcare expenditures. Integration of IT into the healthcare business will be the key to the next jump in healthcare improvement since although labor comprises 80% of total healthcare cost, 80% of incremental benefits are derived from technology. In the future, there will be a trio of technologies: medical informatics, bioinformatics (genomics level), and neuro-informatics (cellular level), which will dramatically impact the level of healthcare. As of now, the World Health Organization is urging countries and businesses to help overcome the valley of death, the funding gap between the basic research conducted in research labs and the steps necessary to move these technologies for commercial use.

Mr. Carl Hendricks, Chief Information Officer of the U.S. Military Health System (MHS) described the delivery of world-class health care to the 9.2 million beneficiaries in the military health system, which is one of the biggest providers of healthcare in the U.S. Over the past year (March 2005 – February 2006), 337,000 patient encounters have been stored electronically in the theater clinical data repository. Patients cannot only access this information through an on-line portal, their TRICARE on-line account, but also schedule and cancel appointments, review their symptoms and diagnosis, research medications and check for potential interactions, review provider and facility information, and also maintain a journal to track their personal health conditions. So far, 425,879 users have registered on TRICARE, which really enables the patient to take more responsibility of their own healthcare needs.

In addition to TRICARE, the MHS has developed the nation's largest and most advanced electronic health record, Armed Forces Health Longitudinal Technology Application (AHLTA), which has been deployed at 94 of 139 facilities. Over 76,500 encounters are recorded daily in AHLTA with a total of 17.1 million patient encounters processed since initial deployment. Of the 9.2 million beneficiaries, 7.65 million have records in the central data repository. In the next phase, AHLTA will incorporate a new medical imaging system, which the MHS is building in coordination with the Veterans Affairs. With cutting-edge technology, the military is able to capture medical information electronically not only in the hospital setting but also across the theater of operations for all services. The MHS hopes that soon 100% of encounters will be captured electronically and this will improve worldwide surveillance on potential emerging threats.

Dr. Yongmin Kim, Chair of the Department of Bioengineering and Professor of Bioengineering and Electrical Engineering at the University of Washington, defined challenges that the healthcare system is facing. He stated that the increasing elderly population in conjunction with the increasing number of patients with chronic conditions, rising healthcare costs, increased complexity of care, and fragility of the current health information are making the current healthcare delivery system unsustainable. He continued his talk by introducing purpose, current status, and trends in the patient-centered medicine, defining specific goals of the D_2H_2 vision and emphasizing driving and supporting technologies.

In his talk, Dr. Kim shared his experiences in the D_2H_2 research, especially on the patient-centered personal health records and early screening on coronary artery disease. Translational research to "bridge the valley of death" was emphasized as the key to the realization of the viable and sustainable D_2H_2 vision. He concluded his talk by mentioning technical and non-technical challenges and opportunities for engineers, scientists, policy makers, customers, care providers, industry and others to facilitate further development and deployment of the new 21st–century paradigm in healthcare delivery.

POINT-OF-CARE DIAGNOSTICS

Dr. Paul Yager, Professor of Bioengineering at the University of Washington, discussed the need for point-of-care diagnostics in the developed and developing worlds. The motivations behind portable, low-cost diagnostics are many; in comparison to the current expensive lab tests that commonly require trained personnel, large volumes of reagents, and waiting times of over 1 day, the vision of 21st-century diagnostics will be devices that anyone can operate, require little volumes of reagents, are disposable, and return results in minutes or seconds. These diagnostics can also be connected to an intelligent controller, which can direct results to the hospital, clinic, and/or primary care provider for further review and/or use. The potential uses of "chemical" D_2H_2 include the monitoring of hospital inpatients and outpatients, screening for diseases, e.g., an early warning system for emergent health conditions (e.g., cancer and cardiovascular), and anticipation of infectious disease outbreaks.

Dr. Yager also stresses that technologies being applied to the developed world must also be developed for the developing world. SARS and avian flu have shown that health problems in the third world can very rapidly spread throughout the world, becoming problems for everyone. Solutions to public health issues in less fortunate areas of the world must be inexpensive. The adoption of point-of-care diagnostics in developing countries may actually be easier since there is no existing infrastructure to overcome. Currently, there are four ongoing research efforts in micro-fluidic diagnostics in his laboratory: salivary testing for epilepsy, detection of myocardial injury through protein markers, enteric pathogen detection using PCR, and blood-born pathogen detection using both immunoassays and PCR.

In 2000, the world market of point-of-care diagnostics was estimated at $4.9 billion. For the U.S., this market has grown from $1.6 billion in 1996 to $2.8 billion in 2001. Clearly, there has been substantial growth in the use of point-of-care diagnostics and devices in the U.S. These devices are now being used at home, in the workplace, at the roadside, in the pharmacy, and even in the mall. Dr. Larry Kricka, Professor of Pathology and Laboratory Medicine at the University of Pennsylvania, described his experiences with point-of-care testing (POCT) in the hospital setting at the University of Pennsylvania Medical Center (UPMC), a system of 3 hospitals, 4200 nurses, and 1 million tests per year. At the UPMC, POCT is a critical tool in the arsenal of lab tests. POCT has been used to get glucose results for immediate intervention, blood gas/electrolytes to adjust ventilator settings and IV fluids, and Parathyroid Hormone (PTH) in order to provide feedback to the surgeon for a patient still in the operating room. For medium complexity tests, POCT is performed by nurses, perfusionists, and respiratory therapists. Other POCT can be performed by certified nurses and medical assistants. Test results are transferred from download sites to a "core system," which screens the results into "flagged results" and "accepted results." "Flagged results" are sent for further review, and "accepted results" are entered into the electronic system. At the UPMC, interconnectivity between the EHR and POCT is essential to the ease of use, integration, and diffusion of these systems into the clinic.

POCT is expected to be reliable, economical, easy to use, interoperable with the EHR, secure, readily repairable/replaceable, and require small volumes of reagents. Since POCT is used for screening and rapid response, the results must be "fail-safe" with clear distinctions between positive and negative results. Sample readouts must be simple and clear; typically, lines, plus/minus, and/or words are used as indicators. Furthermore, Dr. Kricka emphasizes the importance of simple, unambiguous user interfaces and ergonomics. UPMC nurses want the convenience of POCT but not the responsibility for inaccurate results. However, potential challenges include *mis*-reading of results, theft of handheld analyzers, use of devices by unauthorized operators, and other human errors.

Dr. Hon Pak, Chief of Advanced Information Technology Group (AITG) of the U.S. Army Telemedicine and Advanced Technology Research Center (TATRC), gave a history of telemedicine, past, present, and future. He notes that many people believe that telemedicine is a technology typically used in rural settings to connect patients to providers who they may be unable to reach physically. However, this problem is not a problem of only rural settings; for example, in urban areas, the demand for healthcare often exceeds supply, and access to specialists is especially tight. As such, telemedicine offers an alternative delivery mechanism, allowing patients to get the best care possible regardless of location. There are both technical and non-technical challenges involved with telemedicine. One main barrier is the lack of an interoperability standard with EHR. Most current EHR systems are used for documentation, decision support, data mining, and in conjunction with a patient health record/portal system. However, these EHRs are built to document and manage patients being seen in person, not virtual patients. Virtual patients have unique workflow challenges, including registration in the EHR from a telemedicine consult, routing of telemedicine consults to another facility where you have the specialist, and routing of consults to specialists outside the network. There are also technical challenges, including the storage and management of all types of images (DICOM and non-DICOM), whether these images are stored locally or centrally. Another key challenge is the standardizing the art of medicine; for example in dermatology, lighting, resolution, angle of image capture, and comprehensiveness are all challenges unique to virtual patients. The success of telemedicine will depend on its interoperability with EHRs and on whether these other challenges can be overcome.

HOME DEVICES

Dr. William A. Herman, Deputy Director of the Office of Science and Engineering Laboratories of the FDA's Center for Devices and Radiological Health, discussed the FDA's forecast for emerging technology trends and its approach to regulating new devices. He sees the principal drivers of new technology as demographic, economic, and prior technology trends. Eight years ago, home- and self-care was forecast by many high profile futurists as one of the emerging technologies needing significant investment; eight-years later, home- and self-care is still on the list.

At the Center for Devices and Radiological Health, there are over 1,700 types of medical devices, which are broadly classified into class I, II, and III based on risk. Development of new technology can result in revenge effects, i.e., electromagnetic interference, voice *mis*-recognition, touch screen *mis*-calibration, data *in*-security, and finally emergent properties of modular systems that could compromise the success of new devices. Unpredictable emerging properties of technology can appear from systems that combine multiple technologies (even well-tested technologies). Thus, pre-market approval (PMA) including proof of safety and effectiveness with clinical data may be a requirement for new products before the product is even allowed into the market. An Investigational Device Exemption (IDE) can be obtained in order to conduct these clinical trials. In the conventional world, the FDA has acted as a regulatory gatekeeper with unilateral responsibilities and a reactive orientation. In the new transforming world, the FDA would like to use a multifaceted, information-based strategy and work collaboratively with device makers and users through a proactive approach. The main focus of the agency will be on devices that have significant public health issues and require significant regulatory mandates.

Mr. James Keller, Vice President at Emergency Care Research Institute (ECRI), presented the unique problems arising in the home use of medical equipment. There are a wide range of medical products being used on a daily basis, which allows for a very narrow margin of error. Unregulated use of fairly complicated

equipment in an uncontrolled environment and on sicker patients may cause more problems than in a controlled and regulated hospital setting. Apnea monitors, enteral feeding and infusion pumps and dialysis units are all devices commonly proposed for home use. As these devices are critical to the health of the user, they also entail a huge range of liability. Solutions to overcome these issues include more patient support, training and education. The number and complexity of user controls on these home-based devices should be decreased and reduced. If any problems occur, allow for quick and effective recall measures. The inventories of these devices must be closely monitored and tightly controlled. These problems may not become any easier in the near future since technology is getting more complicated and the number of devices being used is constantly increasing.

Dr. Stephen Intille, Technology Director of the House_n Project at MIT, described a novel way of testing new devices in a simulated living environment. He uses ubiquitous computing to create context-aware settings for the proactive health monitoring such as to detect changes in routines and applications that can help people achieve desired behavior changes. In this simulated environment at the House_n, researchers can study the impact of technology on the behavior of people in a natural setting and evaluate the human-computer interfaces in the context of everyday life. There are three opportunities where ubiquitous computing can improve health: in the acute setting where systems detect a crisis, in the chronic setting where systems detect declines in health, and finally in the life setting where systems motivate healthy behavior and/or provide support in all life stages regardless of whether a person is sick or healthy. The focus of most initiatives in the U.S. is on the first two opportunities. The hope is that these new technologies permit the passive tracking of health from a very early stage in life and imbue individuals with more positive and healthy lifestyle.

Dr. Isao Mizukura from Mitsubishi Electric Engineering Co. in Japan discussed "The Home Healthcare Project in Japan," a collaboration of 12 companies subsidized by the New Energy and Industrial Technology Development Organization (NEDO) to explore the use of advanced instruments for monitoring the health conditions of people non-invasively in the comfort of their own home. These ubiquitous home-based devices will monitor ECG, blood glucose and pressure, body temperature, and even body fat, uric salt and sugar. The remote monitoring system collects information from all facets of bodily function to estimate the risk of lifestyle-related diseases and to support the daily management of health. A self check system of vital data will be used to intervene and improve life style if necessary.

Currently in Japan, the medical check-up is usually done once a year. This annual check-up occasionally catches the changing of metabolism, arteriosclerosis, and other conditions. However, sometimes these check-ups may miss potential conditions until they become too severe. The continuous daily monitoring of healthcare in the home has the potential to catch diseases at a much earlier stage, allowing for more prompt and effective interventions. In addition, the multiple data parameters recorded on these devices will allow providers to get a comprehensive picture of an individual's health allowing them to monitor interventions more accurately and alter them if necessary on a regular basis.

Dr. Francis Tay, Group Leader of Medical Devices at the Institute of Bioengineering and Nanotechnology in Singapore, discussed his experiences with MEMSWear, an embedded and wearable device used to monitor normal daily activities and to monitor and intervene in the case of falls. In Singapore, accidents are the fifth leading cause of death among the elderly and two thirds of these deaths result from falls. Even in non-death accidents, falls often cause crippling bone fractures. MEMSWear will enable the elderly to have more independence without the constant oversight of friends and family since it can detect falls and send for help when the wearer falls down. For overall activities, MEMSWear has a sensitivity of 94.9% and a specificity of 98.7% for the 1,495 activities; for falls, the sensitivity is 100% with a lead time of 200 ms. The next step of MEMSWear is to incorporate additional physiological sensors that

can monitor body temperature, blood pressure, and ECG, and send alerts in case a health event is triggered. A second generation of MEMSWear technology will introduce interventions during the lead time between fall detection and the fall. For example, if a potential fall is detected, MEMSWear can send electrical signals to the leg muscles causing them to tense up and prevent the fall.

POSTER SESSION

In the poster session, 44 original research projects covering various aspects of D_2H_2 including point-of-care diagnostics and biosensors, home monitoring and signal processing, telemedicine, interoperability and architecture, and her and PHR were presented, which facilitated in-depth discussion of various issues. These poster papers were included in the Conference Proceedings and geared towards describing research in D_2H_2 enabling technologies, as well as studies in interoperability standards, business models, and health information technology architecture and design.

Addressing point-of-care diagnostics and biosensors, there were seven posters related to the development and use of monitoring and testing devices. One poster discussed the structure and use of amperometric cells to continuously monitor glucose and lactate *in vivo*. There was also discussion of justification of point-of-care testing standards and their application to home monitoring devices, as well as ease of use considerations for design and development of point-of-care testing. The structure of a home device to test respiratory resistance as well as the design of sensors on textile substrates and multimodality sensors used to detect and monitor sleep disorders were also presented.

Home monitoring and signal processing was addressed by 16 posters. Among these, many discussed remote monitoring devices (i.e., devices to monitor patients with congestive heart failure (CHF) and fall detection systems) as well as innovative technology developed to detect healthcare-related conditions, such as the beat-to-beat heart sound analyzer, a portable system developed to monitor heart rate and detect sleep apnea, and a new device designed to screen coronary artery disease. Compression of medical images was discussed, along with a blood pressure waveform monitoring system used to define dynamic blood vessel characteristics.

Telemedicine, interoperability and architecture were discussed through the presentation of 14 posters. This section displayed the results of deploying an orientation information system based on a residential wireless sensor network, a health information sharing system for refugees and immigrants, and innovations made in an Australian e-health research centre. One poster discussed the development of business models focused on integrating chronic disease management and emerging technologies, while another focused on business models involved in a new program called INTERLIFE services. The development of networked and distributed systems used to monitor and diagnose patients outside the clinic was the main focus of this category of posters.

EHR, PHR, and D_2H_2 were addressed through the presentation of seven posters. They focused mainly on the development and deployment of electronic personal health records and the effects of these technologies on the current healthcare system. Some posters discussed the security and integrity of stored patient data, while others discussed the importance of D_2H_2 in the future of healthcare and results from the deployment of patient-owned and patient-managed personal health record systems. One poster focused on the outcome of a patient-centered health record in a regional health network, while another demonstrated the results of deploying a personal health record system in an elderly nursing home.

Dr. John Loonsk, Director of ONC's Office of Interoperability and Standards, outlined the national health information technology agenda and interoperability. He stated many critical needs in healthcare: avoidance of medical errors, improvement of resource utilization, acceleration of knowledge diffusion, reduction of variability in healthcare delivery and access, empowerment of the consumer, strengthening data privacy and protection, and promotion of public health and preparedness. Most clinical practices currently do not use EHRs. Where EHRs do exist, the systems usually do not exchange data electronically with each other, with hospitals, with labs, or with pharmacies. In addition, much of the EHR data must be input manually, impeding adoption by consumers and clinicians. The primary mode of clinical information transfer is still by paper mail, phone, and fax. As a result, a clinician has to spend resources supporting all of these approaches.

It appears that the right confluence of factors: rising healthcare costs, strong endorsement from healthcare industry leaders, substantial benefits for consumers and the economy, and government leadership have finally resulted in a strong drive to integrate the health information technology systems in the U.S. The National Health Information Technology Agenda includes having widespread adoption of interoperable electronic health records within 10 years (by 2014), allowing medical information to be accessible anytime, anywhere by the consumer, enabling clinicians to have complete, computerized patient information, providing quality standards to measure performance and drive quality-based competition, and developing public health and bioterrorism surveillance systems. To achieve breakthroughs in biosurveillance, chronic care management, electronic health records and personalized healthcare, we will need to overcome significant challenges in standards harmonization, privacy, security, and health IT adoption.

Keynote speaker, U.S. Congressman Adam Smith, pointed out that what people really want from healthcare policy can never be delivered: the best possible care for free. It is precisely this reason why it is so difficult to propose healthcare solutions that satisfy everyone. Information technology will be needed to communicate research findings, simplify billings, reduce costs and curb the healthcare cost inflation. He encourages the development of varied solutions and does not want government to reduce innovation through the imposition of regulation and too many standards. He proposes to encourage the adoption of healthcare technology through financial support and grants of various projects.

Mr. Peter Neupert, Vice President of Health Strategy at Microsoft, noted that in our current state the consumer has to provide the interoperability between various health information systems since there are no uniform standards in data between all the providers that a potential consumer may see. This is a lot of additional work for consumers and clinicians, who make sacrifices in time and accuracy since the patient has to remember everything and communicate much of the information necessary for care. In order to personalize care, a priority of the National Health Information Network (NHIN), an information ecosystem must be created to connect together the existing healthcare information. Consumers will not be willing to enter all the data themselves. Information must be connected in order to develop a system that will be able to motivate and engage consumers before they become sick. Family involvement in healthcare will become especially important as people become able to share family histories, need encouragement to seek care, and have additional needs in caretaking situations.

Dr. Doug Perednia, CEO of Kietra Corporation, outlined a radical new way of integrating the current paper-based systems of physician clinics with the electronic health record. He argues that the reason many physicians are hesitant to adopt EHRs is due to the fact that paper records are still more efficient, and since

time is money, there is no incentive to adopt EHRs, which could result in decreased productivity even after their original purchase price. He separates paper as an input medium from paper as an output/recall medium and suggests using paper as an input for EHRs. In the most recent runoff, paper was proven to be faster 6 out of 7 times. Information capture on paper will be in form of structured data grids where doctors can quickly check off the most important and objective health information. Additional unstructured data, such as a doctor's note, can be also be captured and recorded to meet certain regulations. With this type of system, information can be made available to the insurer, provider, and patient simultaneously. The patient may even be a first-level auditor when his or her insurance is billed.

Dr. Niilo Saranummi, Research Professor of the VTT Technical Research Center in Finland, described interoperability as when two or more systems are able to exchange information and are able to use that information more efficiently. Slovenia is an early adopter of HIT and uses a record system based on smartcards. Denmark uses Master Patent Index and secure messaging. Finland uses Integrating the Healthcare Enterprise Cross-Enterprise Document Sharing (IHE XDS). EHR systems are moving from being provider-centered to citizen-centered with new technologies, new channels to market, a customer-centric process, and new skills.

SECURITY AND STANDARDS

Dr. Stanley Huff, Senior Medical Informaticist at Intermountain Healthcare, described how the healthcare software marketplace should shift from a silo model where applications only work within one vendor system to an open model where vendors share Application Programming Interfaces (API) and terminology. Currently, terminology is different across vendors and often different even for customers of the same vendor. This type of model is inefficient since the deployed systems are unable to share information. Moreover, terminology and data modeling work are duplicated by each vendor. He proposes a new healthcare information technology marketplace where application development is separate from the back-end. Common detailed models and terminology are shared as public infrastructure and not used as market advantage or product discriminator. Competition between various vendors would be based on who can make the best application and/or provide the best back-end. In order for this new marketplace to occur, the purchasers of systems – the healthcare institutions – must demand open APIs. Vendors and industry leaders must develop a standard set of detailed clinical data models with standard coded terminology. The current initiatives are in the standards for services being developed in collaboration with the Object Management Group (OMG) and Health Level Seven (HL7), the standardization of terminology through the National Library of Medicine, the National Cancer Institute, the Food and Drug Administration, and others, and in the standardization of terminology models between the College of American Pathologists and HL7. These uniform standards will allow personal monitors that will work with any provider's EHR, allow real-time monitoring of health activity, and enable healthcare clinics that operate similar to the banking systems' ATMs for upload and download of healthcare information.

Mr. Stephen Grimes, Director of Clinical Engineering Services at Vanderbilt University, noted that security is a vital issue for biomedical technology because compromises in data transmission or maintenance can affect the integrity or availability of data, resulting in harm or even death because of delayed or inappropriate treatment. Compromises in confidentiality can also result in loss of patient privacy and, as a consequence, a financial loss to the patient and/or provider organization. In order to safeguard data transmission and maintenance, an effective information security management program as well as a risk analysis/management plan must be established.

Ms. Carla Smith from Booz Allen Hamilton Associate mentioned that consumers do not have a great deal of confidence in organizations keeping and using their health information correctly, securely, and privately. There is a need to look holistically at what an organization is doing for security and crosswalk to find gaps. Security is in each individual's own hands but where should the information be maintained, not only medical, but dental, and mental health information. Where this information will ultimately reside is up for debate. If health information is truly to be used over one's lifetime, it will be critical to maintain a data structure that can adapt to new diagnoses and codes over the course of 50 to 100 years or even longer.

Mr. Neal Neuberger, President of Health Tech Strategies, described the various policies relevant to the development of a nationwide health information network. There are many players: the federal government – Congress and various agencies, state governments including statewide initiatives, and the private sector. He gives HIPAA as an example of how federal regulation overcame a patchwork of hundreds of state laws that were narrow in scope.

FUTURE DOCTOR-PATIENT RELATIONSHIP

Dr. Craig Platenberg, CEO of Pale Blue Glow Imaging, discussed the history of teleradiology from its infancy to the present and its future applications. Since the 1980s, radiologists have been using teleradiology for on-call coverage. Teleradiology drove the development of Picture Archiving and Communications Systems (PACS), PACS drove other domains of telemedicine, and telemedicine is leading to what is now known as e-health. PACS has improved radiologist productivity and the turnaround time for reporting. Recently-developed teleradiology models include the night hawk on-call coverage, solo specialist coverage, and various groups expanding their read base. Night Hawk on-call coverage is available to 80% of practices, and out of practice coverage is emerging with even some instances of out of country coverage. Barriers to teleradiology include licensing across state and national borders, malpractice insurance, and credentialing with third-party payers. Future possibilities for patients include on-line scheduling followed by a study obtained at a local center where DICOM images would be sent to a reading radiologist selected by the patient. The radiologist would read the study and send an interpretation to both the referring physician and patient.

Dr. Mark Snyder, Associate Medical Director of Information Technology at Kaiser-Permanente, discussed experiences with Kaiser's patient portal, My Health Record. He believes that there should not be an intermediary to get lab results or allergy or immunization information. The most frequent request for information is for lab results, and he believes that patients are sophisticated enough to access this information on their own if they wish. Future features that would improve the on-line portal would be patient-questionnaires for pre-visit information gathering, e-visits, health logs, and past medical history. The system has thus far presented minimal additional workload to the staff. 93% of secure messages sent over the network replace other communication modes, such as phone calls and visits. Thus, time used for messaging balances out time clinicians would have spent communicating with patients in another way. Patients want security on one hand but also want convenience on the other. One concern of Dr. Snyder is that some patients may not have the computer literacy required to access the patient portal. He notes that the future is here but unevenly distributed.

Dr. Dan Russler, Vice President of McKesson Corporation, believed that exam rooms are an unnatural environment. As chronic diseases become increasingly prevalent, there will be increased data complexity and more data volume. Both these trends can lead to more room for error. Data should be pushed to the

home where patients have more time to think about and correct answers. His vision is that the doctor's office should be reserved for decision-makings and discussion. If all the data could be collected beforehand, it would be great if the diagnosis could be known before the patient even entered the office.

Mr. Rod Cotton, Senior Vice President of Roche Diagnostics, presented that the drivers behind point-of-care diagnostics lie in lab consolidation, reduction of total healthcare costs, requirements of immediate information, and regulation. However, the reimbursement for point-of-care devices and diagnostics is discouraging in most markets. In many clinics, the lab is seen as the gold standard; thus if POC tests are not seen as reliable or as accurate, they will not be used. Roche is currently collaborating to enable microfluidics research with the goal of miniaturized, rugged, and precise diagnostics.

Ms. Kathy Schweda, Worldwide Business Segment Leader for Pervasive Healthcare Solutions at IBM, described her vision of Personal Health Record Services, which helps patients keep track of their own health information. She proposes open standards, such as the current and future wireless standards, IHE, HL7, which will allow all technology in the health ecosystem to be interoperable. In a chronic condition monitoring scenario, Bluetooth readings from a blood pressure monitor will be sent to the cellular phone, which will dial out and send the readings along with diary entries to a server. The data are then reviewed by a clinician who sends notes back from the server to the cell phone. The cell phone can send the information locally to the individual's computer and also allow the patient to read the diagnosis directly. Individuals will be able to provide additional feedback upon seeing the results of the test. Standards will be increasingly necessary not only for interoperability between various networks, but because it will be easier to find and train employees when the software uses standards.

POLICIES AND STRATEGIES

Dr. Adam Darkins, Chief Consultant for Care Coordination at the Department of Veterans Affairs, described the implementation of the telehealth program at the VA. In 2004, the VA had over 7 million enrollees, including 5 million patients, a 100% increase over 1995 when there were 2.5 million patients and enrollees. The VA system spans 1,300 sites of care including 162 medical centers or hospitals and 800 clinics with 51 million ambulatory care visits and 600,000 hospitalizations. In 2004, there were 188,000 employees at the VA with roughly 15,000 MDs, 56,000 nurses, and 33,000 allied health professionals. This is 18,000 fewer employees than in 1995. Affiliations with 107 academic health systems represent an additional 25,000 affiliated MDs, 100,000 trainees per year and nearly 60% of all U.S. health professionals have some training in the VA. With its size and diverse patient population, the VA is a canary of future population trends and also a testbed to see what will work in a future healthcare delivery system.

The foremost information technology goal at the VA is to finish the development and deployment of a secure national home telehealth information technology infrastructure to support quality care for the veteran. This system would allow veterans at home to get access to their personal health record, education materials, health assessments, medication information, and enable them to make appointments on-line, make payments, and upload additional health information including their current heart rate, blood pressure, weight, etc. Providers would be alerted in case any of the measurements surpassed preset thresholds and can make diagnoses and interventions in real time.

Dr. Michael Fitzmaurice, Senior Science Advisor for Information Technology at the Agency for Healthcare Research and Quality (AHRQ), described AHRQ's work to improve the quality, safety, efficiency, and effectiveness of healthcare for all Americans. The current issues he sees are that costs

continue to rise with a national healthcare expenditure at $1.9 trillion in 2004 and sustained growth at 7.9%. This rate far surpasses both the consumer price index growth rate of 3.3% and the GDP deflator of 2.6%. Moreover, the quality of healthcare in the U.S. is far from optimal; it is estimated that doctors provide appropriate healthcare only about 50% of the time. Access to healthcare across ethnic groups has been narrowing. However, for Hispanics, the majority of disparities in both quality and access are actually getting wider. Moreover, he refers to the oft-cited IOM report that suggests between 44,000 and 98,000 people die in hospitals annually from preventable medical errors, and these costs exceed $9 billion annually. In the U.S., 34% of recently surveyed patients with healthcare problems reported experiencing at least one of four types of errors; of patients who saw at least 4 doctors in the past two years, nearly half reported experiencing at least one of these errors. Dr. Fitzmaurice also mentioned funding opportunities AHRQ provides, including planning and implementation grants, to improve the quality, safety, efficiency, and effectiveness of healthcare for all Americans. He concluded his talk by stressing importance of healthcare information standards, home care and collaborative research efforts.

Mr. Conrad Clyburn of the U.S Army Telemedicine and Advanced Technology Research Center (TATRC) presented the Triple Helix model, which is a DOD's initiative on translational research. He introduced Triple Helix by stating the mission of TATRC, which is to enhance operational and medical decision-making, improve medical training, and deliver medical treatment across all barriers. He emphasized needs and importance of D_2H_2 in the U.S. Army by demonstrating almost 5 times increased research funding in TATRC during the last 7 years. He also stressed leveraging core technology researches, which can transform healthcare and collaborations and technology transfer with various organizations including academic institutions. He shared experiences in Triple Helix, including TATRC information architecture. His talk was concluded by addressing importance of developing core technologies, creative usage and integration of those technologies, and collaborative efforts across various organizations.

Mr. Scot Land, Managing Director of Cascadia Capital, gave a talk entitled "How to Move the Technologies Effectively from the Research Labs into the Marketplace." As the title implies, his talk focused on technology commercialization, especially how to bridge "valley of death." He started his talk by introducing differences between significantly reduced seed stage capital for medical devices before and after the "bubble" and corresponding "valley of death" models. He emphasized widened "valley of death" after the "bubble" and introduced commercialization risk mitigation and smart capital as the way to overcome this widened "valley of death." He mentioned importance of clear path to commercialization, full life cycle of capital planning at inception, and champions to cross the "valley of death." He concluded his talk by mentioning what we need to commercialize D_2H_2, which includes interdisciplinary research and collaboration culture.

SUMMARY

Throughout the course of this conference on D_2H_2, a sobering picture of the current healthcare system and the future of healthcare in the U.S. (and eventually the world) enabled by D_2H_2 were delineated, and all stakeholders were called upon to take their part in the development and deployment of a more distributed healthcare delivery paradigm to provide better quality of care, while containing its cost. Looking at all the stakeholder presentations of past work, current research and development, and future propositions, it is safe to state that technology will be the pulling force into this new era of healthcare and its delivery. Also, how to address key non-technical challenges in D_2H_2 (e.g., stakeholder's resistance and insurance reimbursement) and manage the process of unleashing technological advances will be critical to the success of this new

healthcare paradigm. Moreover, the success is dependent on bridging the 'valley of death' in technologies for D_2H_2 and creating a dynamic and entrepreneurial environment and support system for translational research and closer ties and collaboration between researchers, engineers, industry, clinicians and healthcare organizations. Researchers and engineers need to develop products and services that cater to the needs of consumers by solving important unmet clinical needs. More research needs to be performed regarding enabling technologies, and more emphasis should be put onto complex systems engineering and integration strategies for current and future healthcare systems. The government should invest more resources in the forms of grants and financial support of training a new generation of researchers and engineers who are knowledgeable in complex healthcare issues, research projects, standard development and clinical applications so as to accelerate research, development and evaluation of new technologies and their deployment. Also, all the stakeholders need to increase their involvement in patient education and policy changes to equip and encourage the patient to manage their own healthcare responsibly and modify their behaviors if necessary by providing appropriate incentives and penalties.

Point-of-care diagnostics is one of the key technologies that will enable the realization of the D_2H_2 vision. Its benefits include its portable nature and use of smaller volumes of reagents as well as shorter wait time and the possibility of home use. To fully support the new healthcare vision, the point-of-care diagnostic technology is required to be accurate and economical, both in production and use. For minimally trained personnel to use this technology, ease-of-use guidelines need to be established. Also, a necessary feature of these point-of-care testing devices will be their interoperability with the current EHRs.

Another enabling technology at the forefront of the new era of distributed healthcare is home devices. Home monitoring is becoming a necessity in the world today (and increasingly more so in the future) partly due to the aging population and the rising number of patients with chronic conditions. Home devices should be designed to help in prevention of unhealthy behaviors as well as crisis detection and monitoring the health of chronically-ill patients outside of the clinical setting. In order to be able to be used by the consumer effectively and correctly (e.g., patient, home nurse and relative of patient), these devices should be easy to use, and comprehensive directives, instructions and assistance should be given to the patients. These devices should also be robust against environmental variations, operator dependencies, and errors.

The Internet is regarded as another enabling technology that is critical to the success of the D_2H_2 vision. It is sometimes seen as the link between other D_2H_2 enabling technologies and the clinic. Integrating these systems into the clinical workflow has been projected to be a large contributor to the transformation of the current healthcare system. Other major pulling forces behind the need for distributed diagnosis and care in the form of electronic health records (EHRs) and personal health records (PHRs) are the need for faster diffusion of medical knowledge, the need for reduction of medical errors, duplication of tests and misdiagnosis, and the need for more comprehensive knowledge bases of healthcare information. Many speakers pointed out that although there are many EHRs and PHRs already developed, most require the manual input of information, which can lead to no or slow adoption due to the increased workload and the workflow impediment of system integration into the clinic. The increased workload for the clinic and the absence of a clear economic benefit or incentive (cost savings, higher reimbursement, less penalty or government subsidy) can lead to difficulty in system adoption in general and especially in smaller clinics. The government and the private sector need to help align incentives between the developers and the clinic, helping to make decisions regarding access and ownership of the patient data, and support R&D in projects that support interoperability and security. Developers of EHRs and PHRs, such as TRICARE, AHLTA and IHE XDS as well as developers of new systems, research institutions and government organizations, such as ONC, should collaborate more and develop a unified standard(s) of health information exchange between these current systems and future ones.

This new healthcare delivery system will introduce a new patient-doctor relationship based on partnership, where the patient will be involved in their healthcare more actively by being responsible for data collection and managing their health along with the provider, and where the provider-patient interactions in the clinic will have room for more decision-making and discussion. The patient will be enabled to be more informed and involved in their healthcare decisions, and they will have access to their complete health information including lab results and tests. The overall healthcare system will be defined as patient-centered, distributed prevention, diagnosis and treatment, where the provider can be an overseer and aide to the patient in his/her more informed healthcare decision-makings and proactive management. To facilitate a smooth transition into increasingly distributed healthcare delivery from existing hospital-centric care and to balance the resources and care, carefully thought-out incentives, policies and strategies need to be developed, tried and optimized.

As was noted by many of the speakers at the conference, the era of a new healthcare delivery system is on the horizon, and stakeholders from government, industry, and academia as well as employers, insurance companies, care providers, and individuals need to come together to define a smooth path towards D_2H_2. By various stakeholders collaborating on D_2H_2 and its implementation and deployment, this new paradigm can be realized, and rising healthcare costs can be contained along with improved quality of care for the increasingly aging and chronically-ill populations. Emphasis on early detection and prevention needs to be valued as well as ease of use and monitoring in the development of enabling or disruptive technology and integration into clinical systems. Interdisciplinary research and collaboration needs to be encouraged and supported in various ways to facilitate a quick transfer from clinically-useful technology to widespread commercialization.

Many believe that the D_2H_2 paradigm, with all the stakeholders working together toward the common and societal good, will aid in developing a sustainable 21st-century healthcare system with the potential to improve accessibility to healthcare, increase care quality, and control healthcare costs.

CONCLUDING REMARKS

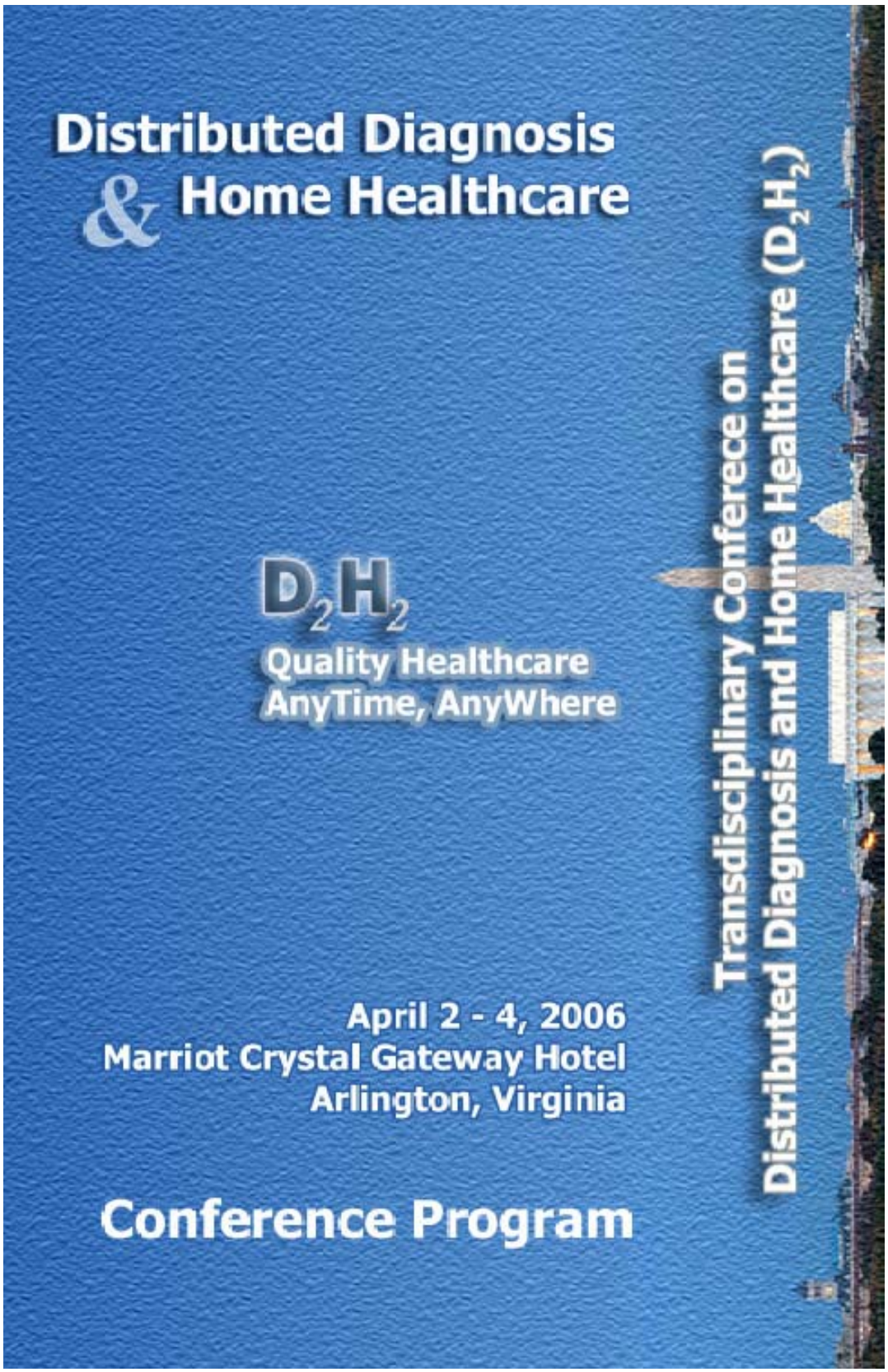
"Rome was not built in a day."

At the first transdisciplinary conference on Distributed Diagnosis and Home Healthcare (D_2H_2), we have taken the first step toward realizing the future healthcare delivery paradigm to improve quality, safety, efficiency, and effectiveness of healthcare. The conference was very successful. Leaders from academia, government, and industries have participated in active discussion at the conference with more than 200 participants to exchange ideas and to discuss various aspects of issues and opportunities associated with realization of the D_2H_2. We found a congenial spirit toward D_2H_2 at the conference, gaining huge momentum, and many believed that D_2H_2 is the most reasonable solution to overcome crisis in current healthcare delivery. As series of the D_2H_2 conference progress and prevail, we believe that we will be getting closer to see the D_2H_2 paradigm being used in homes and clinics in a daily basis.

MISCELLANEOUS:

The presentation materials of the invited speakers are available at
http://emed.icsl.washington.edu/d2h2 and http://www.uwemed.org/d2h2.

APPENDIX: CONFERENCE PROGRAM



D_2H_2

Quality Healthcare
AnyTime, AnyWhere

Dear Colleagues:

Welcome to the inaugural event of the Transdisciplinary Conference on Distributed Diagnosis in Home Healthcare (D_2H_2)! The goal of D_2H_2 is to improve the quality of care and patient wellness and outcomes by transforming the delivery of healthcare from a central, hospital-based system to one that is more patient-centered, distributed and home-based for both the developed and developing countries. D_2H_2 will benefit patients and the society by improving the quality and convenience of care, controlling healthcare costs and increasing access to affordable and effective healthcare in the world.

The main purpose of this conference is to bring together the major stakeholders from industry, academia and government to discuss the current status, important components/ingredients, new technologies, and policies to facilitate distributed, home healthcare delivery in the future.

Due to its complexity and scope, D_2H_2 requires researchers, engineers and providers from many traditional disciplines to collaborate and tackle the challenges together. Thus, this conference on D_2H_2 is sponsored by many professional societies, e.g., American Medical Association (AMA), American Society of Mechanical Engineers (ASME), Healthcare Information and Management Systems Society (HIMSS) and Institute of Electrical and Electronics Engineers (IEEE), with a total combined membership approaching one million members. We would like to express our sincere appreciation of the financial and programmatic support from US Army Medical Research and Materiel Command and several other organizations.

We, the Program Committee members, have worked hard to develop an exciting conference program that we feel will generate discussion and will benefit the forward motion of this important issue in the 21st century. There are many state-of-the-art research and studies in D_2H_2 to be presented in the poster session. Please make sure that you spend enough time in reviewing the posters on April 3, 2006 (Monday).

Thank you for participating and we hope you will enjoy the program, meet new people, exchange ideas, and learn about technical and non-technical issues and opportunities associated with this future healthcare delivery paradigm.

Sincerely yours,

Yongmin Kim, Ph.D.
D_2H_2 Conference Chair
Hunter and Dorothy Simpson Endowed Chair
Department of Bioengineering
University of Washington
Seattle, WA 98195 USA

Sunday April 2, 2006	
3:00 pm - 6:00 pm	Registration/Check In (Grand Registration Desk)
6:00 pm - 8:00 pm	Opening Reception

Monday April 3, 2006	
7:00 am - 4:00 pm	Registration/Check In (Grand Registration Desk)
8:00 am - 8:30 am	Continental Breakfast (Foyer of Salons A & B)
8:30 am - 10:15 am	**Opening and Vision (Salons A & B)**
Chair: Yongmin Kim, Ph.D. Simpson Endowed Chair and Professor of Bioengineering at the University of Washington	
Dr. Lee Huntsman, President Emeritus of the University of Washington *"The Imperative for Technology to Change Health Care - Again"*	
Dr. Jean-Claude Healy, Director of Office of the ADG, External Governing Bodies of World Health Organization *"Towards A Health Society"*	
Mr. Carl Hendricks, U.S. Military Health Systems Chief Information Officer *"The Military Health System: Empowering Providers and Patients Through IT"*	
Dr. Yongmin Kim, Chair and Professor of Bioengineering at the Univ. of Washington *"Distributed Diagnosis and Home Healthcare (D2H2)"*	
10:15 am - 10:40 am	Coffee Break (Foyer of Salons A & B)
10:40 am - 12:00 pm	**Point-Of-Care Diagnostics (Salons A & B)**
Chairs: Michael Rozen, MD, Vice Chair of the IEEE-USA Technology Policy Council Swee Chuan Tjin, Ph.D., Professor of Electrical and Electronic Engineering, Nanyang Technological University, Singapore	
Dr. Paul Yager, Robert F. Rushmer Professor of Bioengineering at the University of Washington *"Point-of-Care Diagnostics for the Developed and Developing Worlds"*	
Dr. Larry Kricka, Professor of Pathology and Laboratory Medicine at the University of Pennsylvania *"Point-of-Care Testing (POCT): Lessons from the Hospital World"*	
Dr. Hon Pak, Chief of Advanced Information Technology Group (AITG) of the U.S. Army TATRC *"HIT Convergence: EHR Interoperability with Telemedicine"*	
12:00 pm - 1:15 pm	Lunch Break
1:15 pm - 3:00 pm	**Home Devices**
Chair: Gary Fletcher, Ph.D., Director of Core Technologies of BD Diagnostics	
Dr. William A. Herman, Deputy Director of the Office of Science and Engineering Laboratories of the FDA *"Emerging Home Care Technologies and the FDA"*	
Mr. Jim Keller, Vice President, Health Technology Evaluation and Safety of ECRI *"Special Safety Considerations for Medical Devices in the Home Care Environment"*	
Dr. Stephen S. Intille, Technology Director of House_n at MIT *"Using a Live-In Laboratory to Study Novel Proactive Health Technologies"*	
Dr. Isao Mizukura, Chief Scientist of Technology Research Association of Medical and Welfare Apparatus and Mitsubishi Electric Engineering Co. *"Home Healthcare Project in Japan"*	
Dr. Francis Tay, Group Leader of Medical Devices at the Institute of Bioengineering and Nanotechnology of Singapore *"MEMSWear - Wearable Biomonitoring Systems"*	
3:00 pm - 3:30 pm	Coffee Break (Sky View)
3:30 pm - 5:30 pm	Poster Session (Sky View)

6:00 pm - 8:00 pm	Evening Banquet
Speaker: Jerome Grossman, M.D., Senior Fellow and Director of the Harvard/Kennedy School Health Care Delivery Policy Program *Building a Better Delivery System: A New Engineering/Health Care Partnership*	

Tuesday April 4, 2006	
7:00 am - noon	Registration/Check In (Grand Registration Desk)
8:00 am - 8:30 am	Continental Breakfast (Foyer of Salons A & B)
8:30 am - 10:15 am	**EHR, PHR, Telemedicine and Interoperability**
Chair: Michael Ackerman, Ph.D., Assistant Director of National Library of Medicine	
Dr. John Loonsk, Director of ONC's Office of Interoperability and Standards *"The National Health IT Agenda and Interoperability"*	
Special Keynote Speech by U.S. Congressman Adam Smith	
Mr. Peter Neupert, Corporate Vice President of Microsoft *"Empowering the Consumer with Technology"*	
Dr. Doug Perednia, CEO of Kietra Corporation *"Instant EHRs: Using Hybrid Technology to Mass Produce and Distribute Electronic Health and Patient Record Data"*	
Dr. Niilo Saranummi, Research Professor at VTT Technical Research Center of Finland *"Current Status of eHealth Interoperability in Europe"*	
10:15 am - 10:40 am	Coffee Break (Foyer of Salons A & B)
10:40 am - 12:00 pm	**Security and Standards**
Chair: Ram D. Sriram, Ph.D., Manager of Manufacturing Metrology and Standards for the Health Care Enterprise at NIST	
Dr. Stanley M. Huff, Senior Medical Informaticist, Intermountain Healthcare *"Standards for Database Services: An Opportunity to Change the Healthcare Software Marketplace"*	
Mr. Stephen Grimes, Director of Clinical Engineering Services, Vanderbilt University *"Managing Security of Medical Devices Networked over Diverse Environments"*	
Ms. Carla Smith, Booz Allen Hamilton *"Information Security Standards and Practice"*	
Mr. Neal Neuberger, President of Health Tech Strategies *"Policies in Security, Privacy, and Confidentiality"*	
12:00 pm - 1:15 pm	Lunch Break
1:15 pm - 3:00 pm	**Future Doctor-Patient Relationship**
Chair: Jon Linkous, Ph.D., Executive Director of American Telemedicine Association	
Dr. Craig Platenberg, CEO of Pale Blue Glow Imaging *"Everything You Wanted to Know About the Rad in Teleradiology But May Have Been Afraid To Ask"*	
Dr. Mark Snyder, Associate Medical Director of Information Technology at Kaiser-Permanente *"Use of Internet Tools to Facilitate Patient-Physician Communication"*	
Dr. Dan Russler, Vice President of McKesson Corporation *"The Future of Patients and Physicians in an IHE Regional Health Information Organization (RHIO)"*	
Mr. Rod Cotton, Senior Vice President of Roche Diagnostics *"The Point of Care Market - Market Drivers and Current Trends in the Point of Care Sector"*	
Ms. Kathy Schweda, Worldwide Business Segment Leader for Pervasive Healthcare Solutions at IBM *"The Importance of Open Standards for Distributed Diagnostics and Home Healthcare"*	

3:00 pm - 3:30 pm	Coffee Break (Foyer of Salons A & B)
3:30 pm - 5:00 pm	**Policies and Strategies**
Chair:	Seong K. Mun, Ph.D., Professor of Radiology and Director of ISIS at Georgetown University
	Dr. Adam Darkins, Chief Consultant for Care Coordination at the Department of Veterans Affairs *"Developing Large National Telehealth Networks to Support the Routine Delivery of Care"*
	Dr. Mike Fitzmaurice, Senior Science Advisor for Information Technology, AHRQ *"Health Information Technology Research: Laying the Groundwork for Strategic Implementation"*
	Mr. Conrad Clyburn, TATRC, U.S. Army *"Triple Helix: Technology Management Involving Government, Industry, and Academia"*
	Mr. Scot Land, Managing Director of Cascadia Capital *"How to Move the Technologies Effectively from the Research Labs into the Marketplace"*
5:00 pm	Closing Remarks and Conclusion of Program

Posters on Point-Of-Care Diagnostics and Biosensors
"Micromachined Amperometric Cells for Continuous Monitoring of Glucose and Lactate," R. Dudde, G. Piechotta, and R. Hintsche, *Fraunhofer Institute Silicon Tech, Germany*
"Sensors on Textile Substrates for Home-Based Healthcare Monitoring," T. H. Kang, C. R. Merritt, B. Karaguzel, J. Wilson, P. Franzon, B. Pourdeyhimi, E. Grant, and T. Nagle, *North Carolina State University and University of North Carolina Chapel Hill*
"Ease of Use Considerations for Wearable Point-Of-Care Devices in Home Environments," J. Yao, S. Simmons, and S. Warren, *East Carolina University and Kansas State University*
"In-Home Hand-Held Device to Measure Respiratory Resistance," J. Vossoughi, A.T. Johnson, and N. K. Silverman, *Engineering and Scientific Research Associates and University of Maryland*
"Dry-Reagent Storage for Disposable Lab-On-A-Card Diagnosis of Enteric Pathogens," S. Ramachandran, J. Gerdes, P. Tarr, P. Yager, L. Dillman, R. Peck, M. Kokoris, M. Nabavi, F. Battrell, D. Hoekstra, and B. H. Weigl, *University of Washington, Micronics, Inc., Washington University in St. Louis, and PATH*
"A Distributed Multimodality Sensor System for Home-Used Sleep Condition Inference and Monitoring," Y. T. Peng, C. Y. Lin, and M. T. Sun, *University of Washington and IBM*
"The Case for Applying the Point of Care Testing Standard to Home Monitoring Devices," M. L. Ingeholm, T. M. J. Hu, F. Fang, S. K. Mun, and B. A. Levine, *Georgetown University*

Posters on Home Monitoring and Signal Processing
"Diagnostically Lossless Compression-2 of Medical Images," R. Ashraf, M. Akbar, and N. Jafri, *National University of Sciences and Technology, Pakistan*
"Home Monitoring of Congestive Heart Failure Patients," B. A. Levine, E. McAlinden, T. M. Hu, F. Fang, A. Alaoui, P. Angelus, J. Welsh, and S. K. Mun, *Georgetown University*
"The Relationship between Pulse Transit Time and Systolic Blood Pressure on Individual Subjects after Exercises," M. Y. M. Wong and Y. T. Zhang, *Chinese University of Hong Kong*
"A Customized Human Fall Detection System Using Omni-Camera Images and Personal Information," S.-G. Miaou, P.-H. Sung, and C.-Y. Huang, *Chung Yuan Christian University and Industrial Technology Research Institute, Taiwan*

"Gait Analysis for Detecting a Leg Accident with an Accelerometer," T. Yoshida, F. Mizuno, T. Hayasaka, K. Tsubota, S. Wada, and T. Yamaguchi, *Tohoku University and Nagoya Institute of Technology, Japan*
"Automated Beat-To-Beat Heart Sound Analyzer for Distributed Diagnosis and Home Healthcare Application," P. Wang, L. H. Ling, Y. Kim, and C. B. Soh, *Nanyang Technological University, Singapore, National University of Singapore, and University of Washington*
"A Passive and Portable System for Monitoring Heart Rate and Detecting Sleep Apnea and Arousals: Preliminary Validation," D. C. Mack, M. Alwan, B. Turner, P. Suratt, and R. A. Felder, *University of Virginia*
"Low-Cost Detection and Monitoring of Coronary Artery Disease Using Ultrasound," S. Sikdar, V. T. Shamdasani, M. S. Lidstrom, K. W. Beach, and Y. Kim, *University of Washington*
"A Semi-Reversible Watermark for Medical Image Authentication," F. Ahmed and I. S. Moskowitz, *Catholic University of America and Naval Research Laboratory*
"Ultrasound Machine for Distributed Diagnosis and Home Use," Y. M. Yoo, F. K. Schneider, A. Agarwal, T. Fukuoka, L. M. Koh, and Y. Kim, *Nanyang Technological University, Singapore and University of Washington*
"Content-Based Video Preprocessing for Remote Monitoring of Neurosurgery," J. Xu, R. J. Sclabassi, B. Liu, and M. Sun, *Yunnan University, China and University of Pittsburgh*
"Mobility Assessment Using Event-Related Responses," M. Pavel, A. Adami, M. Morris, J. Lundell, T. L. Hayes, H. B. Jimison, J. Kaye, *Oregon Health and Science University*
"Monitoring Computer Interactions to Detect Early Cognitive Impairment in Elders," H. B. Jimison, N. Jessey, J. McKanna, T. Zitzelberger, and J. Kaye, *Oregon Health and Science University*
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